The Ring Current, the Plasmasphere, and Penetration Electric Fields

Mike Liemohn

Aaron Ridley

University of Michigan, Ann Arbor, USA

Outline:

Epen Observations

Ring Current Model

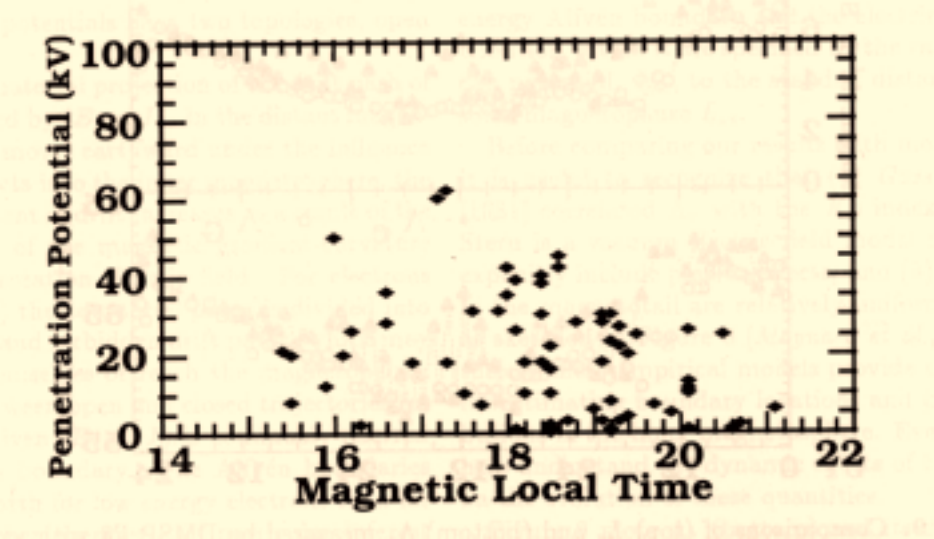
Ring Current Simulations

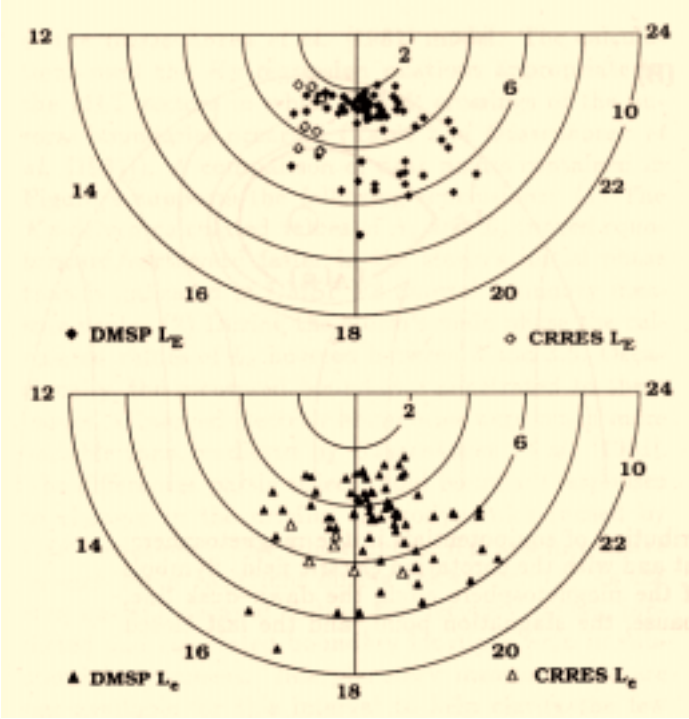
RC-Derived Epen Results

Epen Influences

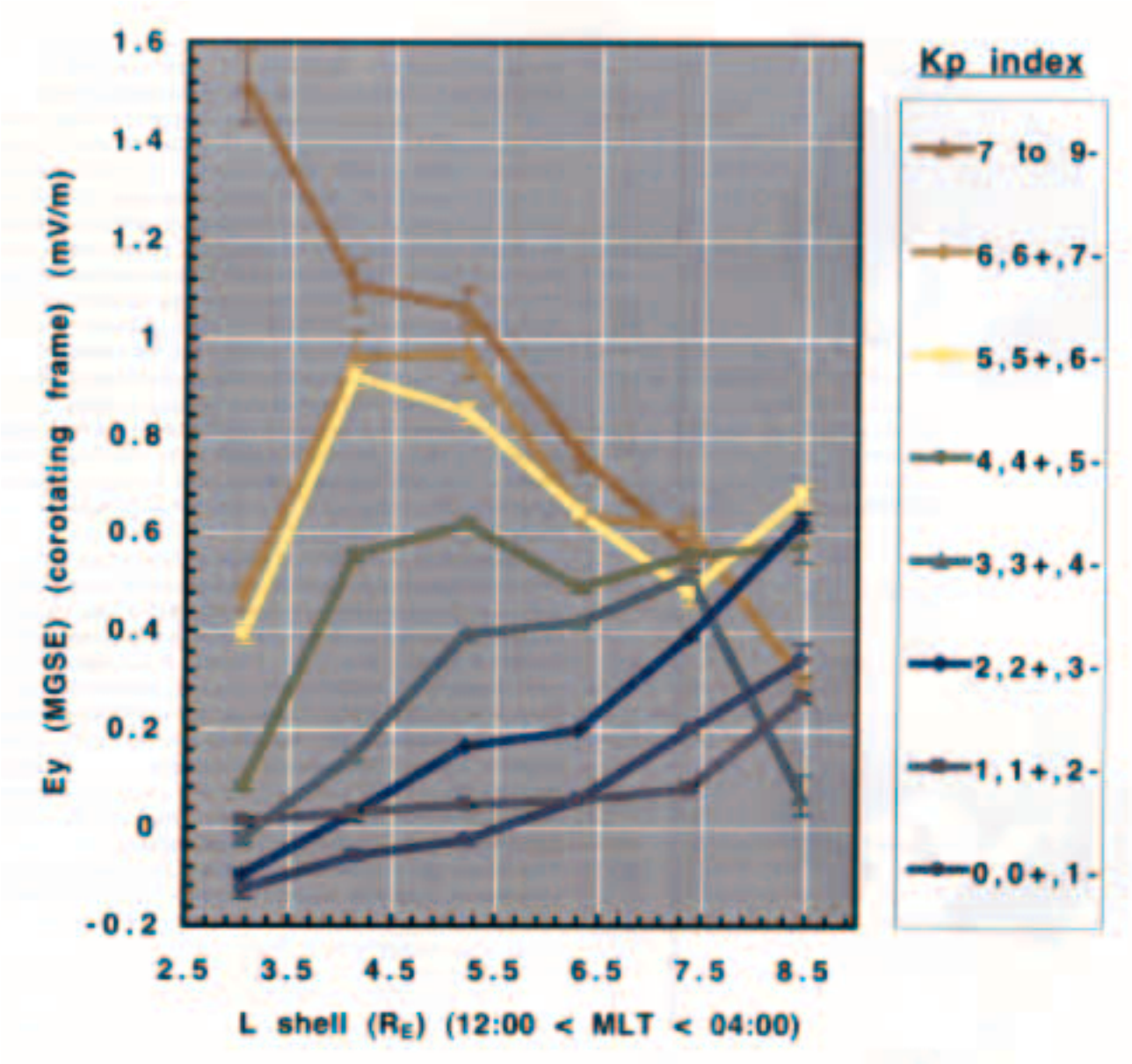
Epen-ΔDst Relationship

DMSP Φ_{pen} Observations

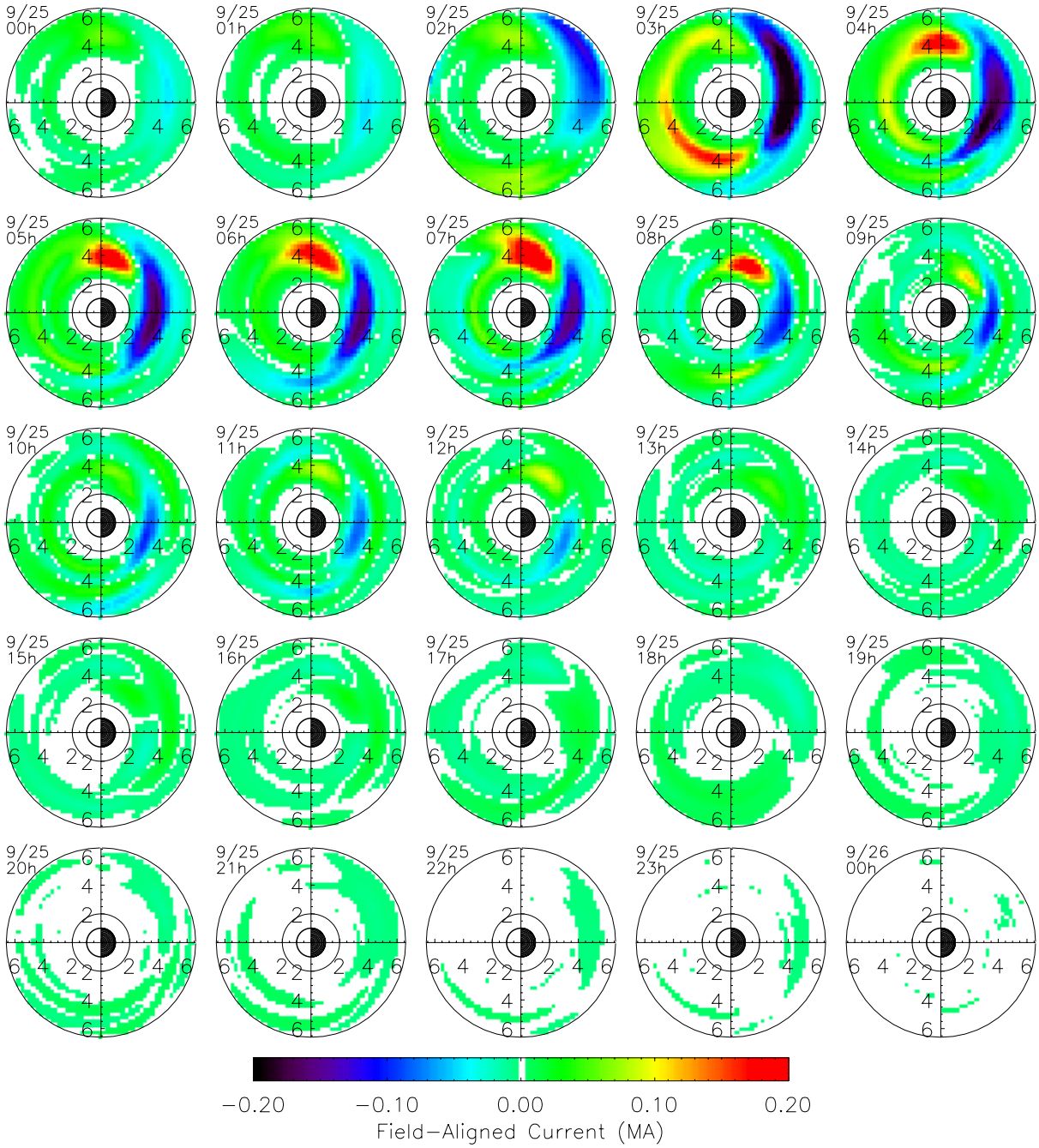




CRRES Φ_{pen} Observations

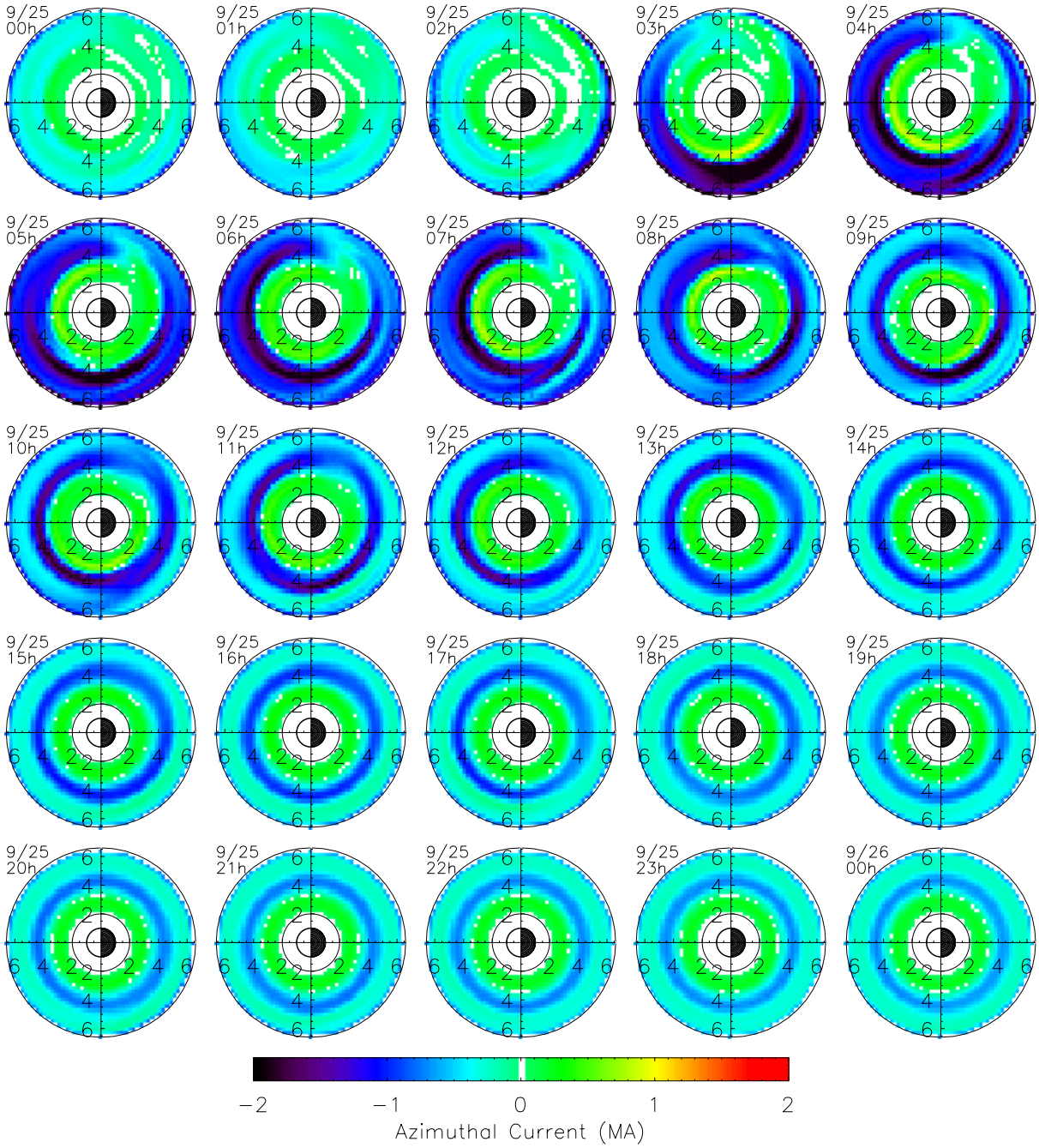


September 25, 1998



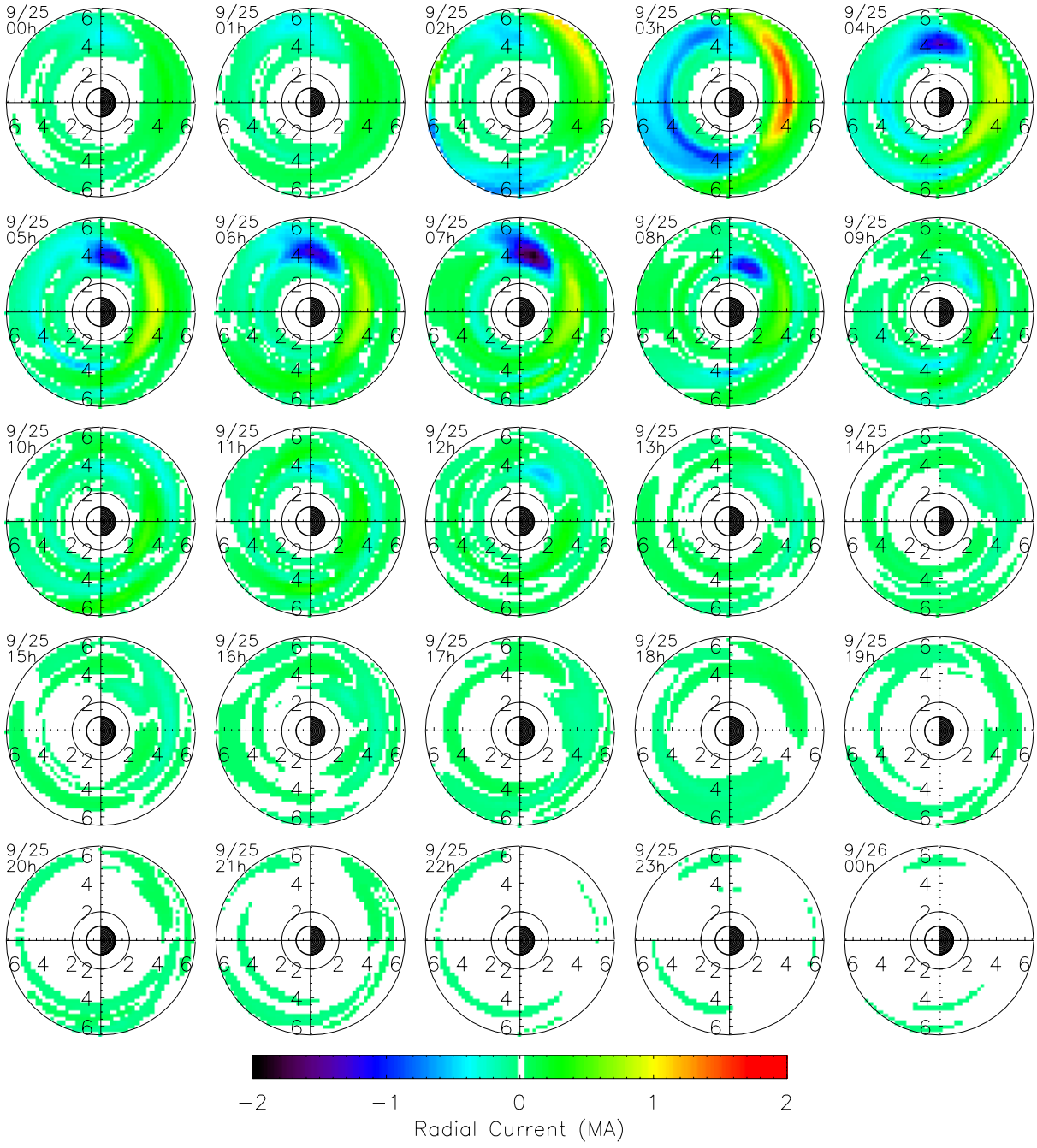
Current Into and Out of the Ionosphere

September 25, 1998



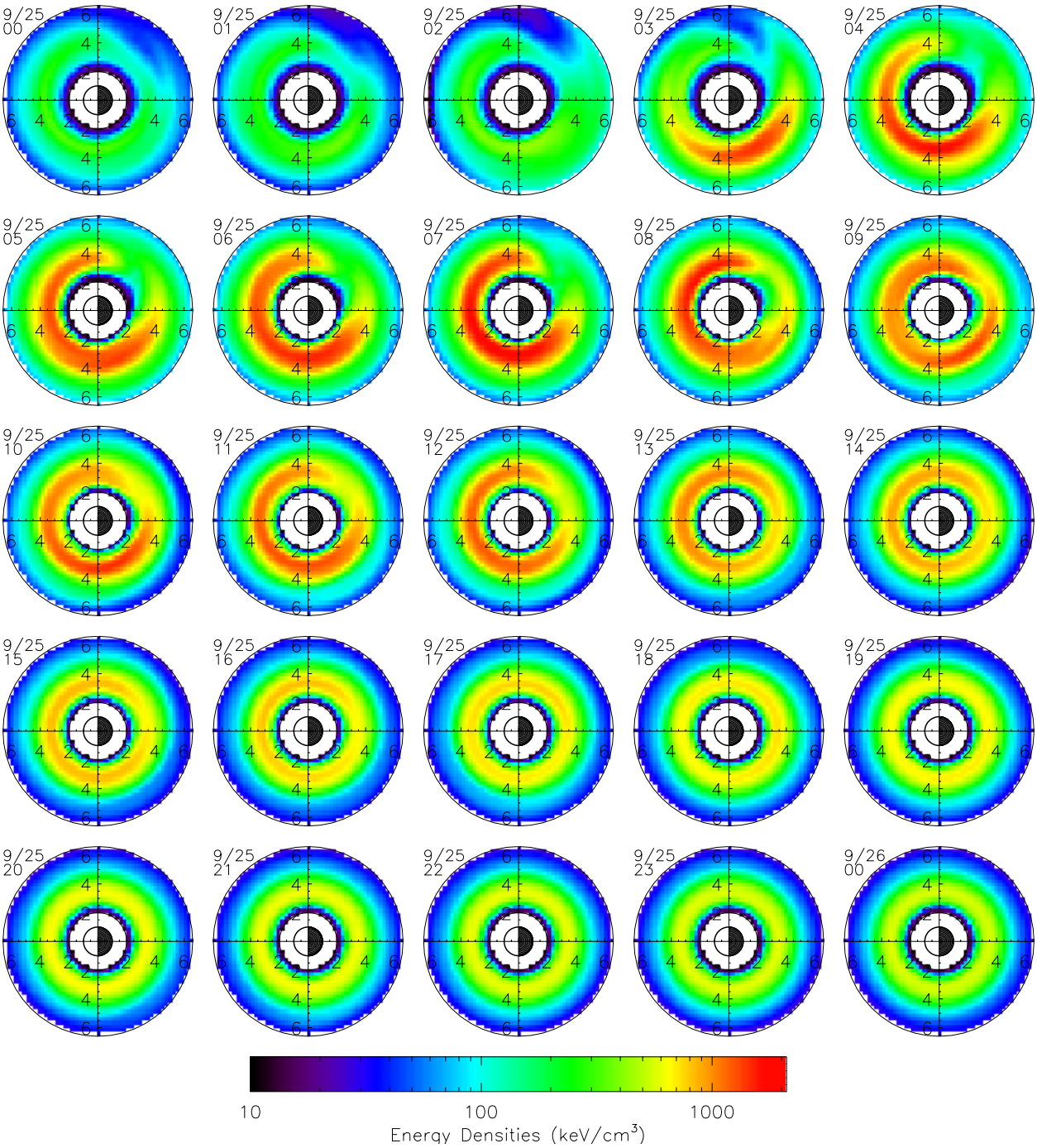
Magnetospheric Azimuthal Current

September 25, 1998



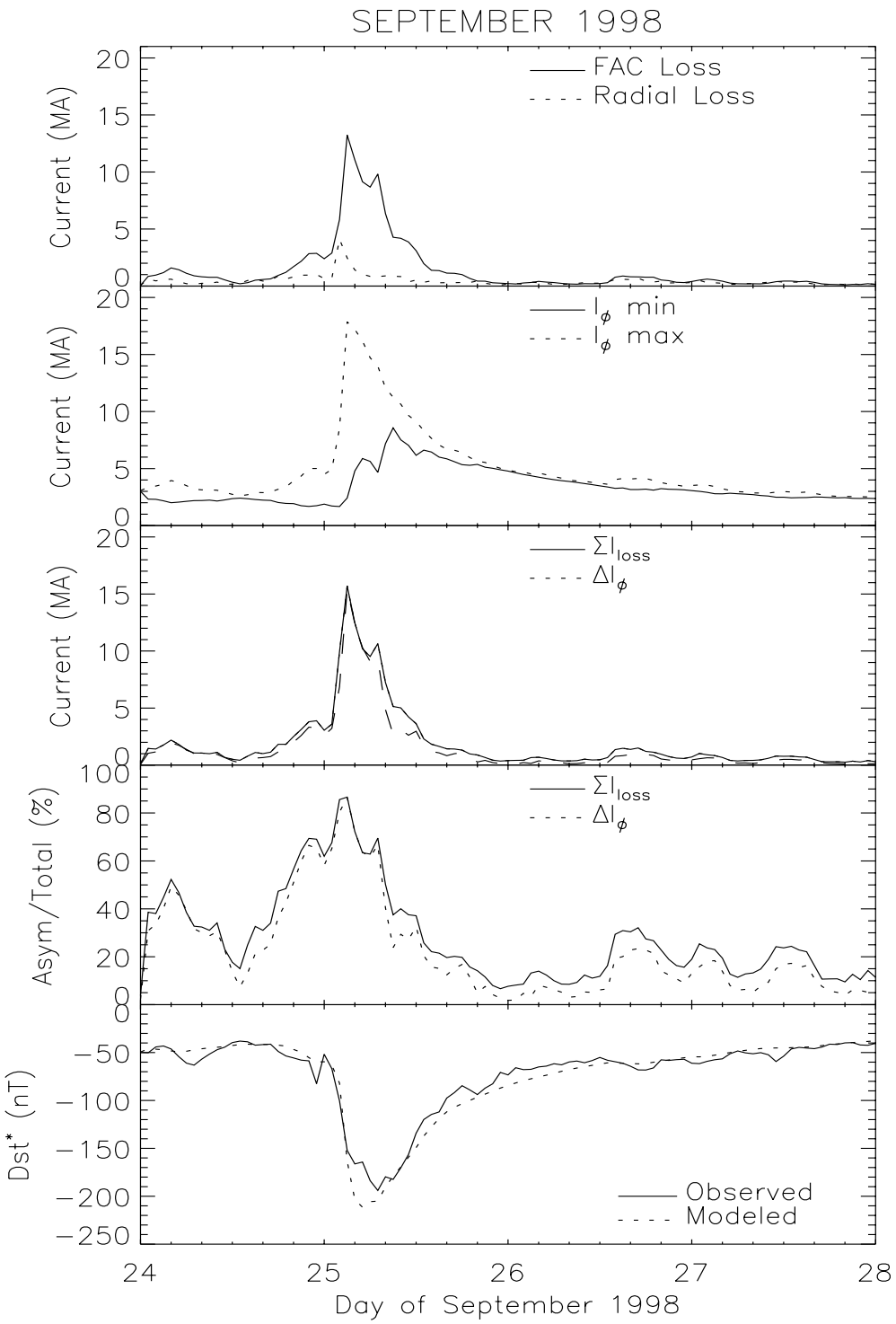
Magnetospheric Radial Current

September 25, 1998



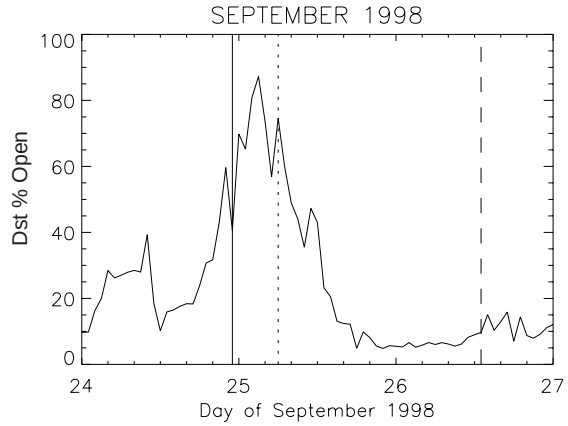
Magnetospheric Energy Density

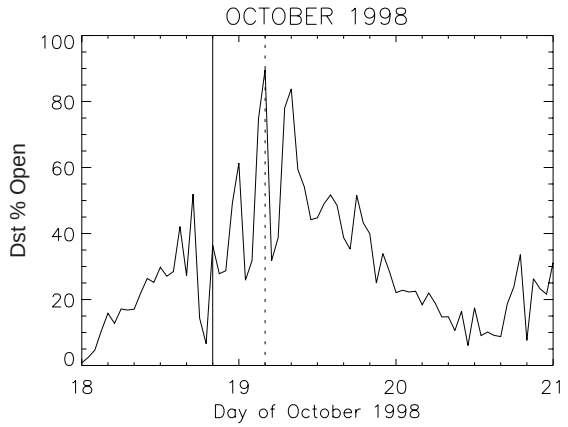
September 1998: Currents

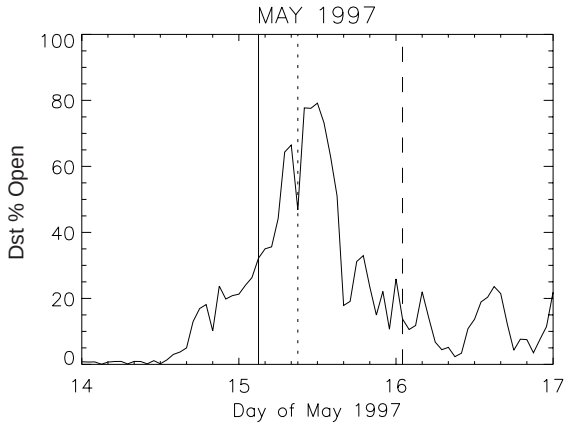


Integrals of the Ring Current

Particle Trajectory Analysis

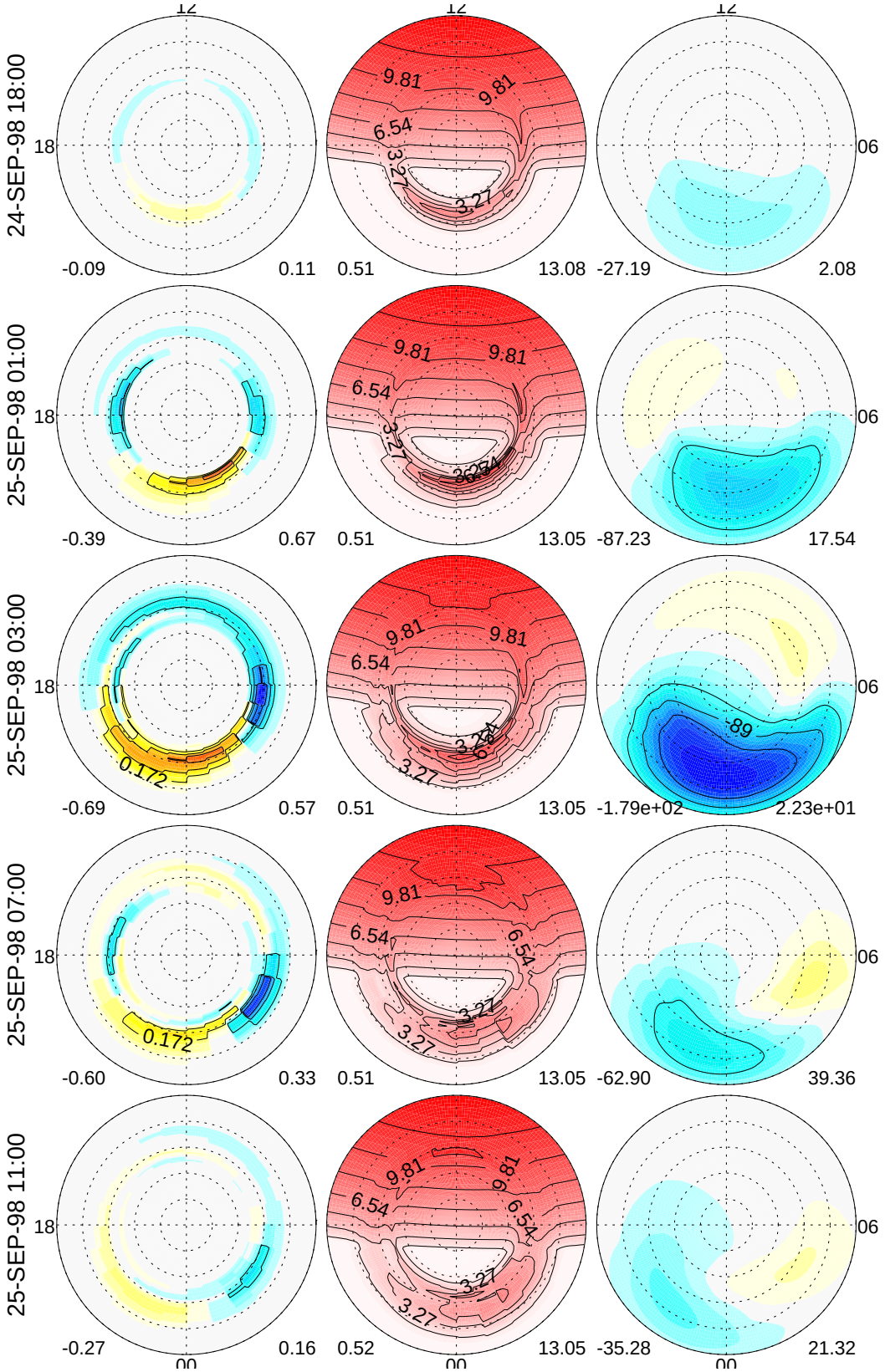




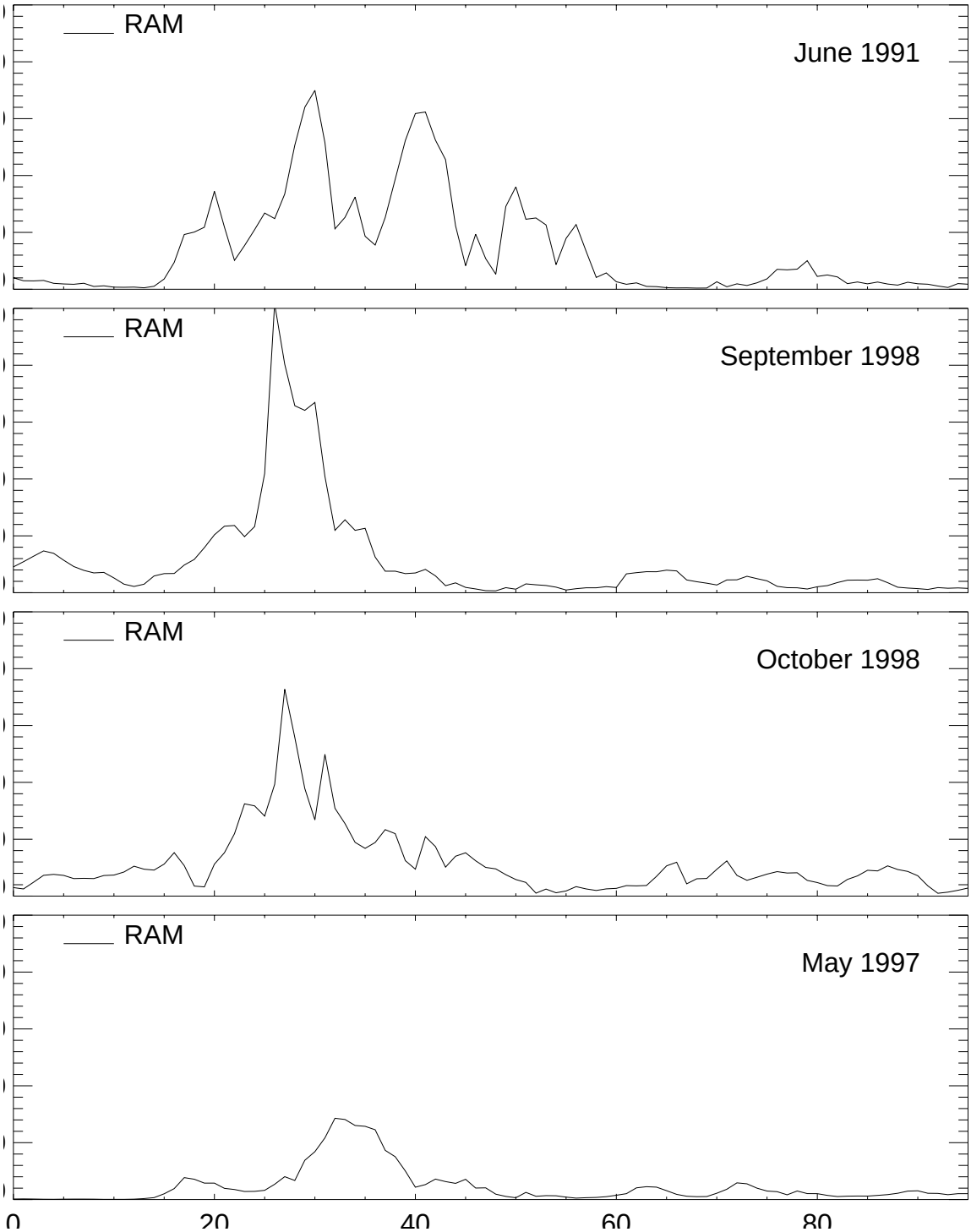


Percent of the Ring Current on Open Drift Paths

Φ_{pen} Calculations

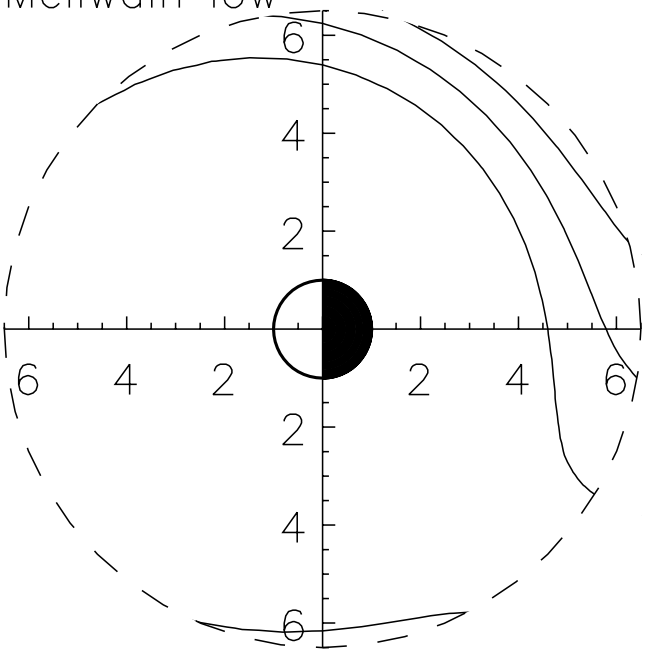


Cross Polar Cap Φ_{pen}

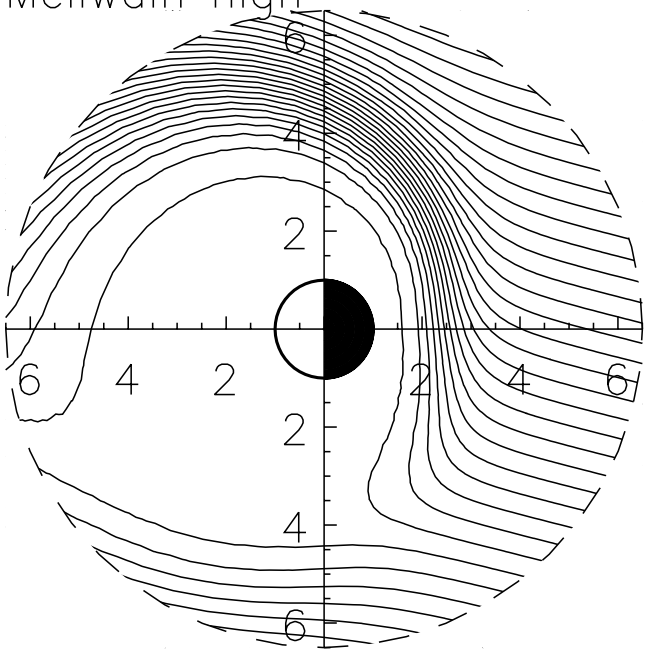


Potential Patterns

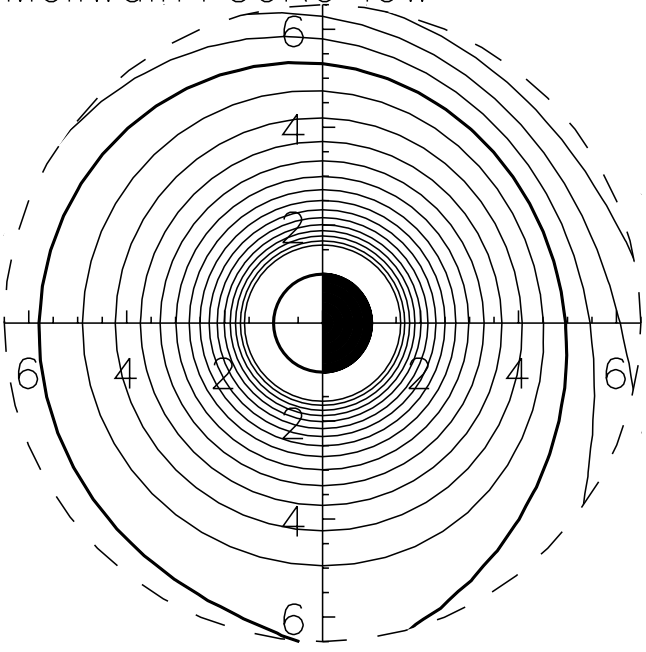
McIlwain low



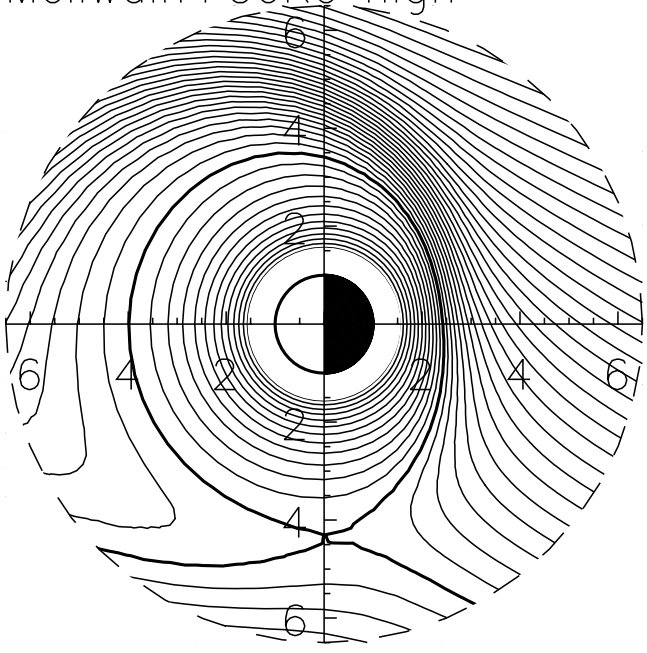
McIlwain high



McIlwain+CoRo low

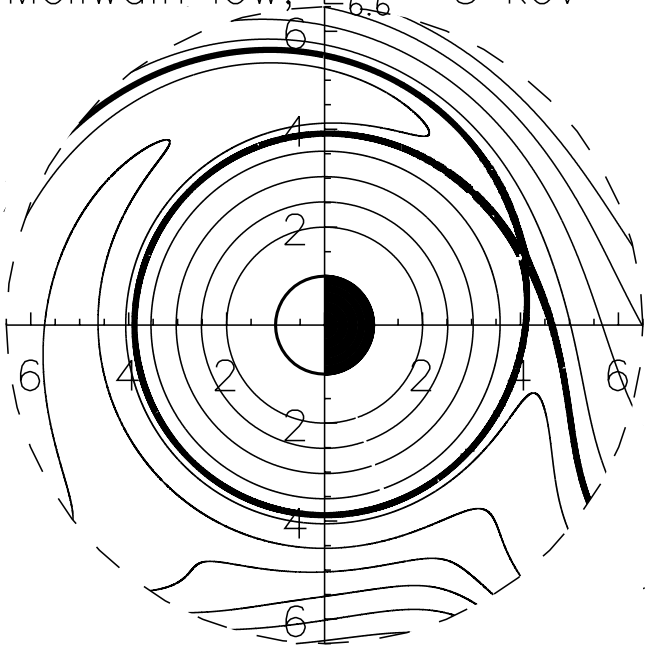


McIlwain+CoRo high

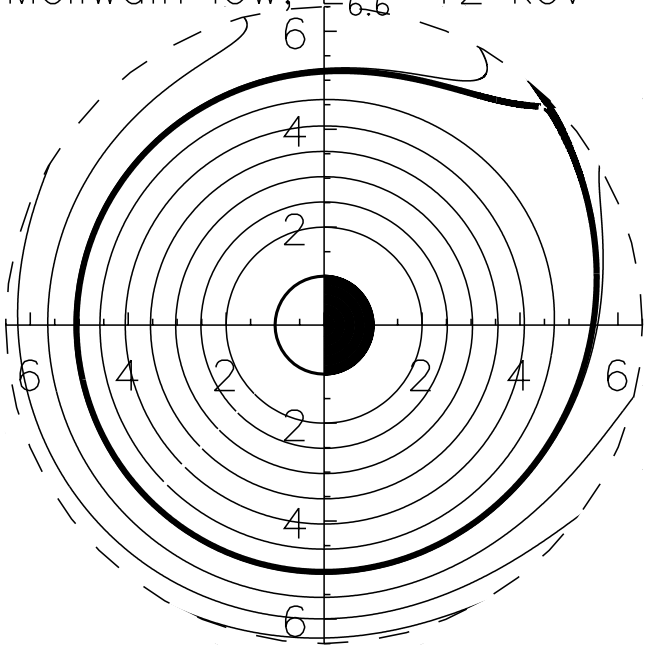


RC Ion Trajectory Patterns

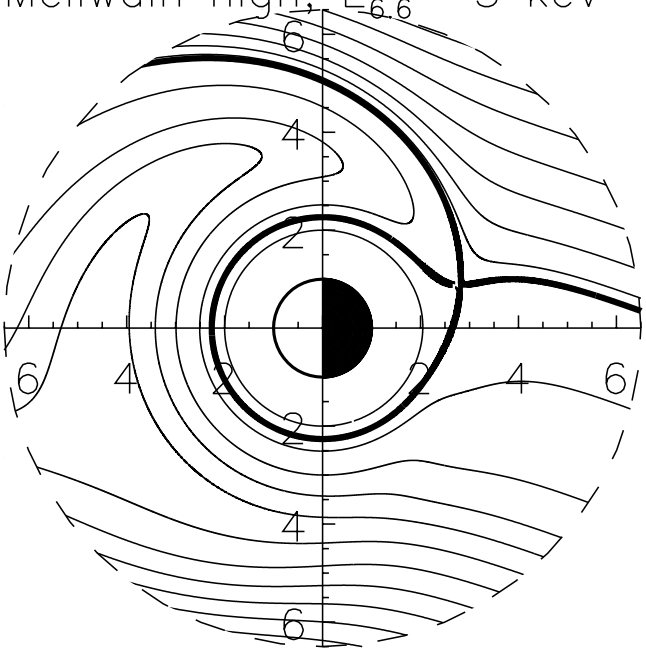
McIlwain low, $E_{6.6}$= 3 keV



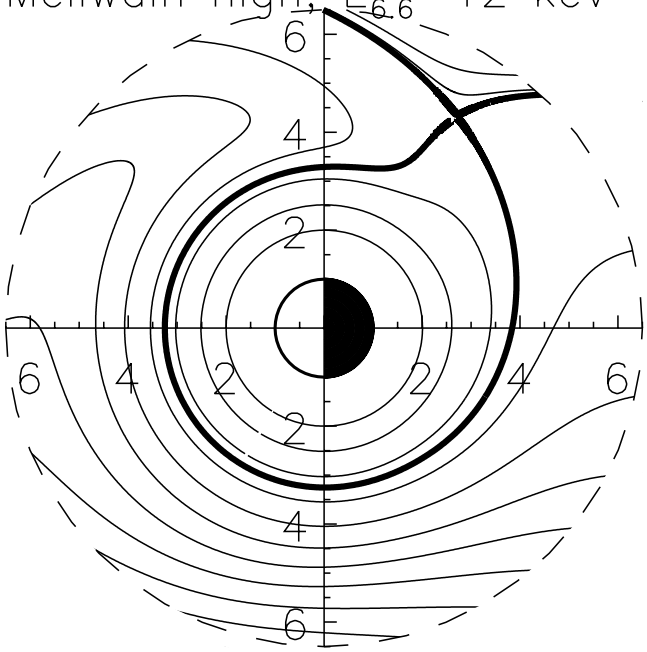
McIlwain low, $E_{6.6}$=12 keV



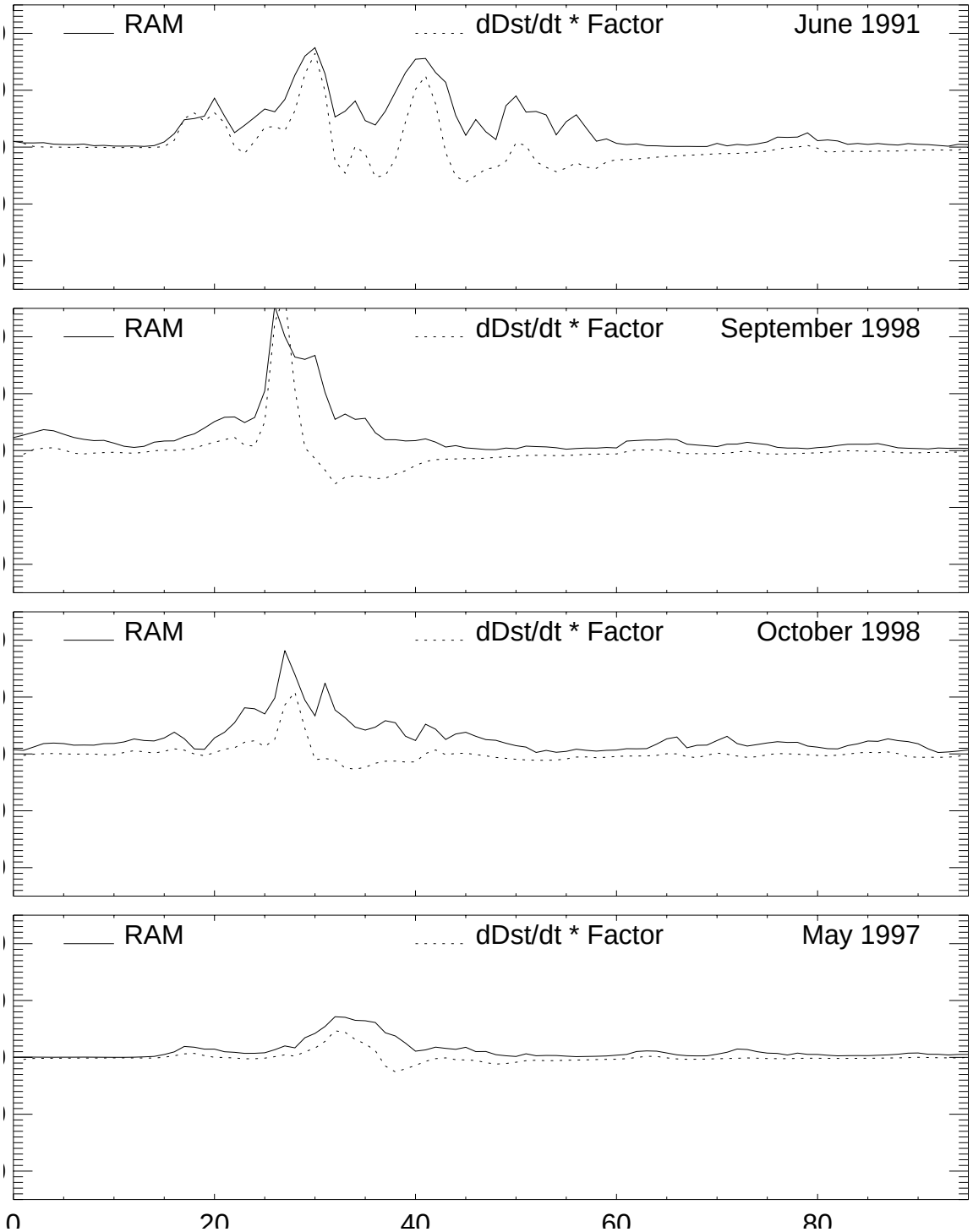
McIlwain high, $E_{6.6}$= 3 keV



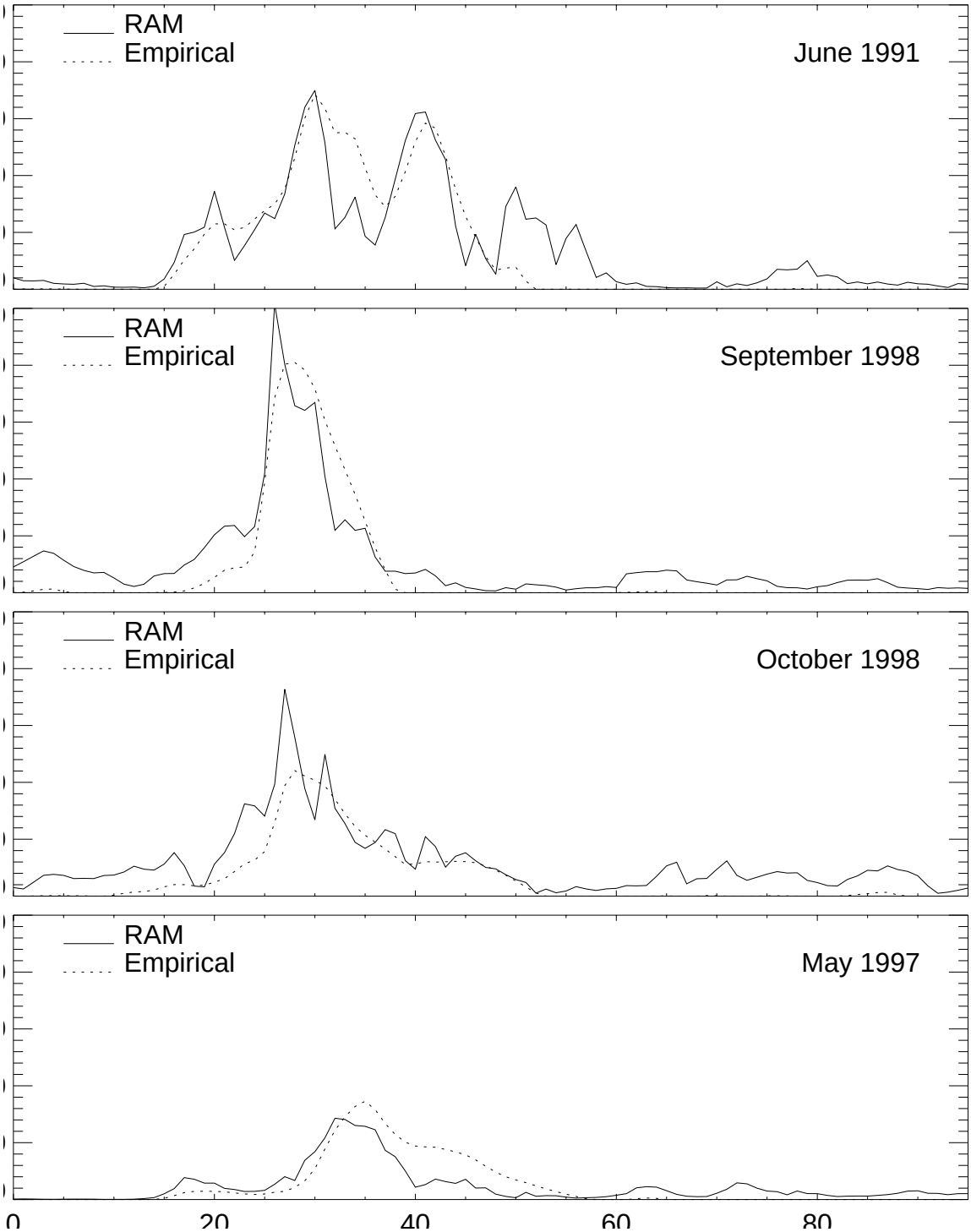
McIlwain high, $E_{6.6}$=12 keV



Φ_{pen} and dDst/dt



Prediction of Φ_{pen}



Summary

- **Penetration fields are real**
  - **Seen by CRRES, DMSP, and Millstone Hill**
  - **Observations are most likely lower limits**
- **A ring current source**
  - **Storm time RC is highly asymmetric (>80%)**
  - **FACs from $\nabla \cdot J_{\perp}$**
  - **Most of $J_{\perp}$ closes inside of geosynchronous**
- **Penetration field is large (stormtime only)**
  - **Maximum CPCP ranged from 80 to 250 kV (4 storms)**
  - **Mostly on the nightside where conductivity is low**
  - **Swings around on the nightside with FAC distribution**
  - **Non-consistent model yields upper limits on penetration field strength**
- **Impact of penetration field is huge**
  - **Completely changes the stormtime potential pattern**
  - **Significantly impacts the RC ion trajectories**
  - **Feedback on RC-generated FAC pattern will limit size**
  - **Most likely influences plasmaspheric topology**
- **Penetration field scales well with ΔDst**
  - **Linear relationship with first and second derivatives of Dst can predict the penetration field strength**